Notes to Accompany Fixed Roof Tank Calculations

Note 1: Roof Outage

Determines average height of roof above shell walls. Algorithm depends on whether tank roof is conical or domed. Equations 1-6 and 1-7, AP -42, Chapter 7.1, Storage of Organic Liquids.

Algorithm:

For cone roof tanks:

Roof Height ÷ 3

For dome roof tanks:

Height × (0.5 + (2 × Roof Height ÷ Diameter)^2 ÷ 6)

Note 2: Vapor Space Volume

Equations 1-3 and 1-4, AP -42, Chapter 7.1, Storage of Organic Liquids

Algorithm:

π × (Diameter ÷ 2)^2 × (Shell Height - Liquid Height + Roof Outage)

Note 3: Turnovers

Divides throughput by tank capacity

Algorithm:

Throughput ÷ Tank Capacity

Note 4: Turnover Factor: See Figure 7.1-18

Equation 1-24, AP -42, Chapter 7.1, Storage of Organic Liquids

Algorithm:

if Turnovers ≤ 36: 1

if Turnovers > 36:

(Turnovers + 180) ÷ (6 × Turnovers)

Note 5: Tank paint solar absorptance Factor

Factors derived from Table 7.1-6, AP -42, Chapter 7.1, Storage of Organic Liquids

	Paint Condition	
Paint Color	Good	Poor
Specular Aluminum	0.39	0.49
Diffuse Aluminum	0.60	0.68
Light Gray	0.54	0.63
Medium gray	0.68	0.74
Primer Red	0.89	0.91
White	0.17	0.34

Note 6: Average Surface Temperature (Fahrenheit)

Equations 1-13, 1-14, and 1-15, AP -42, Chapter 7.1, Storage of Organic Liquids. Assuming Average Ambient Temperature of 56.8 degrees fahrenheit and solar insolation as 1608 Btu/square foot-day as per Table 7.1-7, annual entry for Santa Maria, California. Paint factor determined by Paint Color and Paint Condition.

Algorithm:

56.24 + (16.06 × Paint Factor)

Note 7: Maximum Surface Temperature (Fahrenheit)

Algorithm:

Average Surface Temperature + (0.25 × Diurnal Vapor Temperature Range)

Note 8: Minimum Surface Temperature (Fahrenheit)

Algorithm:

Average Surface Temperature - (0.25 × Diurnal Vapor Temperature Range)

Notes to Accompany Fixed Roof Tank Calculations

Note 9: Product Factor
Factor defined as part of Equation 1-23, AP -42, Chapter 7.1, Storage of Organic Liquids; 0.75 for Crude Oil, 1.00 for other liquids.

Note 10: Diurnal Vapor Temperature Range
Equation 1-17, AP -42, Chapter 7.1, Storage of Organic Liquids. Assuming diurnal ambient temperature range of 23° F and solar insolation of 1608 Btu/square foot-day as per Table 7.1-7, entry for Santa Maria, California.
Algorithm:
16.56 + (45.02 × Paint Factor)

Note 11: Diurnal Vapor Pressure Range
Equation 1-19, AP -42, Chapter 7.1, Storage of Organic Liquids
Algorithm:
0.5 × (7261 - 1216 × ln (Reid Vapor Pressure)) ×
True Vapor Pressure × Diurnal Vapor Temperature Range ÷
(Average Surface Temperature (Rankine))^2

Note 12: Vapor Molecular Weight
As per Table 7.1-2, AP -42, Chapter 7.1, Storage of Organic Liquids.

Gasoline RVP 13:	62
Gasoline RVP 10:	66
Gasoline RVP 7:	68
Crude Oil:	50
Jet naphtha (JP-4):	80
Jet kerosene:	130
Distillate fuel oil No. 2:	130
Residual Oil No. 6:	190

Note 13: True Vapor Pressure (at average liquid surface temperature)
As per Table 7.1-3, AP -42, Chapter 7.1, Storage of Organic Liquids. Interpolated using Liquid Surface Temperature. Crude oil TVP calculated using equation 1-12a. Constants (A and B) in equation 1-12a are calculated using equations in Figure 7.1-16.
Algorithm:
if Petroleum Liquid = Gasoline RVP 13:
6.9 + (0.14 × (Average Surface Temperature - 60)) ,
if Petroleum Liquid = Gasoline RVP 10:
5.7[a] + (0.05 × (Average Surface Temperature - 60)) ,
if Petroleum Liquid = Gasoline RVP 7:
3.5 + (0.06 × (Average Surface Temperature - 60)) ,
if Petroleum Liquid = Jet naphtha (JP-4):
1.3 + (0.03 × (Average Surface Temperature - 60)) ,
if Petroleum Liquid = Jet Kerosene:
0.0085 + (0.00025 × (Average Surface Temperature - 60)) ,
if Petroleum Liquid = Distillate fuel oil No. 2:
0.0074 + (0.00029 × (Average Surface Temperature - 60)),
if Petroleum Liquid = Residual Oil No. 6:
0.00004 + (0.000001 × (Average Surface Temperature - 60)),
if Petroleum Liquid = Crude Oil:
exp ((12.82 - (0.9672 × ln (Reid Vapor Pressure)) -
((7261 - 1216 × ln (Reid Vapor Pressure)) ÷
(Average Surface Temperature + 460)

[a]AP -42, Table 12.3-2, lists the base TVP as 5.2

Notes to Accompany Fixed Roof Tank Calculations

Note 14: Vapor Density
Equation 1-9, AP -42, Chapter 7.1, Storage of Organic Liquids
Algorithm:
Molecular Weight × True Vapor Pressure ÷ (10.731 × Average Surface Temperature (Rankine))

Note 15: Vapor Space Expansion Factor
Equation 1-16, AP -42, Chapter 7.1, Storage of Organic Liquids
Algorithm:
(Diurnal Vapor Temperature Range ÷ Average Surface Temperature) + ((Diurnal Vapor Pressure Range - 0.06) ÷ (14.7 - True Vapor Pressure))

Note 16: Vapor Saturation Factor
Equation 1-22, AP -42, Chapter 7.1, Storage of Organic Liquids
Algorithm:
1 ÷ (1 + (0.053 × True Vapor Pressure × (Shell Height - Liquid Height + Roof Outage)))

Note 17: Breathing Loss (tons/year)
Equation 1-2, AP -42, Chapter 7.1, Storage of Organic Liquids.
Algorithm:
365 × Vapor Space Volume × Vapor Density × Vapor Expansion Factor × Vapor Saturation Factor ÷ 2000
Controlled Breathing Loss = (0.05 × Breathing Loss) for tanks with vapor recovery.

Note 18: Working Loss (tons/year)
Equation 1-23, AP -42, Chapter 7.1, Storage of Organic Liquids. Assumes no working loss for wash tanks.
Algorithm:
if (Tank Type = Wash , 0 , 0.001 × Molecular Weight × True Vapor Pressure × (Throughput ÷ 42) × Turnover Factor × Product Factor ÷ 2000)
Controlled Working Loss = (0.05 × Working Loss) for tanks with vapor recovery.

Note 19: Flashing Loss (tons/year)

Equation derived by the American Petroleum Institute:
Algorithm:
Throughput x Volume of Vapor Vented x V